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The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum

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Abstract: This study charts the design and development of a pioneering design-led multidisciplinary innovation Master's degree; a degree in Design Thinking. It reviews a decade of delivery of the programme and considers the contextual factors that influenced its original design and subsequent iterations. The study uses a critical participatory action research methodology and draws on previous research conducted on and through the programme in question, together with stakeholder surveys and interviews. The programme in question has evolved from its original manifestation as a teaching programme to an entity that acts as a locus for education, research, and practice in design-led innovation. As such, the study identifies four essential stakeholders—students, partner organisations, society, and academia—whose priorities have formed the contextual elements that have driven the programme's introduction and development. It considers their influence on the programme design and the values derived by each from the programme. Furthermore, the study reveals the underlying pedagogic principles and aspects of delivery that have ensured that these values are delivered.

Keywords: Design Thinking Education, Multidisciplinary Innovation, Design-led Innovation, Critically Reflective Design Thinking

Introduction

Design Thinking is at the heart of this article. Education in Design Thinking is the subject of enquiry and, to a large extent, the methodology employed in that enquiry. There is an increasing body of literature relating to Design Thinking (Brown 2009; Kimbell 2011 and 2012; Nussbaum 2011; Carlgren, Rauth, and Elmquist 2016), and there are multiple definitions offered by academics, practitioners, and professional organisations. They do not all agree, and the literature is mixed regarding both the definition and value of Design Thinking. There is, however, a broad consensus that Design Thinking takes advantage of the designers' attitude (Michlewski 2015) together with design tools in order to democratise creative endeavour in pursuit of user-centred responses in complex situations. Indeed, Carlgren, Rauth and Elmquist (2016) identify five themes with which to frame Design Thinking: user focus, problem framing, visualisation, experimentation, and diversity. In her vociferous attack on Design Thinking, Jen, in her 2017 keynote talk at the ADOBE 99u conference, summarises the folly of its claim, thus: "design thinking packages a designer's way of working for a non-designer audience by codifying their processes into a prescriptive, step-by-step approach to creative problem solving – claiming that it can be applied by anyone to any problem." Notwithstanding the criticism that Jen implies, there are two important factors evident in her summary: that Design Thinking intends to enable "non-designers" to engage in creative activity and that some proponents seek to codify or formalise a process for Design Thinking.

In their study "Design Thinking: An Educational Model towards Creative Confidence," Rauth et al. (2010, 7) define Design Thinking within the teaching context as "a learning model which supports design creativity, utilizing project and process-based learning by emphasising creative confidence and competence." For the purpose of this article, the authors draw on their own experience of Design Thinking, from designers' perspectives, and consider that it a) is very

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much about using design approaches to enable "non-designers" to engage in creative endeavours, and b) does not need to be codified into a prescriptive process.

This article looks back at the development of a programme of study and the influences and factors that shaped it over time. For this reason, contemporaneous sources are used to contextualise the work and, in the article, we use the term "Design Thinking" as shorthand for Design-led Multidisciplinary Innovation.

In 2005 and 2006 a number of reports were commissioned that shed light on different aspects of the UK creative industries covering policy and infrastructural recommendations and emerging trends. These reports included the Cox Review of Creativity in Business (Cox 2005), the NESTA reports on measuring innovation (2006a) and growing and investing in creative businesses (2006b), the Audi Foundation sponsored report on UK design excellence (Whyte and Bessant 2006), and the Work Foundation report on the economic performance of the UK creative industries (Work Foundation/DCMS 2007).

One of the key recommendations from the Cox Review was the establishment of Centres of Excellence that sought to "tackle the issue, in higher education, of broadening the understanding and skills of tomorrow's business leaders, creative specialists, engineers and technologists" (Cox 2005, 4). The Higher Education Funding Council for England established a funding stream to support this, which was also reinforced by growing acknowledgement of the role of multidisciplinary and co-creative activity in design practice and academe, the aforementioned "Design-Thinking." Collectively, these trends indicated that there was:

1. An economic need for graduates who could drive innovation by delivering creativity in business through multidisciplinary projects.
2. Interest in the value delivered by Design Thinking as an approach to addressing complex business challenges.
3. A position about the competencies needed of individuals to thrive within collaborative and multidisciplinary environments.
4. Interest and funding to investigate ways that academia might explore this emerging role for multidisciplinary design to drive economic growth.

In response to these drivers, in September 2007, Northumbria University launched a Master's programme to develop advanced study of collaborative design innovation within a diverse community of graduates coming from design, engineering technology and business backgrounds. It was to be called MA/MSc Multidisciplinary Design Innovation.

After a decade of delivery of this programme, this study seeks to answer the question "what are the critical elements required to deliver Design Thinking education within a changing landscape?" It explores the original design and iterative development of the programme, the contextual factors that influenced this, and the consequent values derived from it by the programmes' stakeholders. Rather than presenting a detailed discussion of the various pedagogic devices deployed in the programme delivery, the study refers to the principles that underpin them.

Methodology

A mixed method approach has been employed in compiling this study, with critical participatory action research at its core. Kemmis, McTaggart, and Nixon in *The Action Research Planner: Doing Critical Participatory Action Research* (2013, 4–5), state that "participants have special access to how social and educational life are conducted in local sites by virtue of being 'insiders.' " They suggest that critical participatory action research affords special access to, and influence on, the practice, which is beneficial to research as the researchers are very active in "individual and collective self-reflection that actively interrogates the conduct and consequences of participants' practices, their understanding of their practices, and the conditions under which

they practice, in order to discover whether their practices are, in fact, irrational, unsustainable or unjust" (Kemmis, McTaggart, and Nixon 2013, 6). They do this rigorously because participants are "profoundly interested in their practices" (Kemmis, McTaggart, and Nixon 2013, 6). In addition to critical participatory action research, which has been used to review well over 100 projects undertaken through the programme with organisations ranging from one-person charities to Fortune 500 corporations, semi-structured interviews and surveys with stakeholders and contemporaneous mandatory institutional programme evaluations have all been used to inform this study.

The act of designing and developing this new programme with Design Thinking at its core was, in itself, an act of Design Thinking. Various models for Design Thinking processes exist, arguably the most popular being that of d-School (Hasso Plattner Institute of Design 2018) which promotes linear activity through five stages: empathise, refine, ideate, prototype, and test. This model provides a helpful structure or set of scaffolding for those who are uncomfortable with the ambiguity inherent in the co-evolution of problem and solution that this sort of work involves (Dorst and Cross 2001). According to Andrea Kershaw of IDEO, "only practice and experience make this way of working a second nature" (IDEO, Design for Europe and Nesta 2017). Indeed, more experienced practitioners are comfortable to move back and forth between the various stages, and not necessarily follow them sequentially. Dorst (2011) highlights how experienced designers tend to seek out the central paradox in any given situation before starting work to find solutions, and in referring to an earlier study, he identifies how the most experienced practitioners, seek to understand the broader contextual issues influencing the central paradox. In the case of this study, the main protagonists were highly experienced practitioner academics with a deep understanding of the many institutional and contextual issues surrounding the central paradox: educating across disciplinary silos. They therefore started from a position of deep empathy, with well-defined questions, and began the process of developing the programme with the prototyping and testing stages, delivered through pilot projects, which allowed the team to establish empathy with the wider stakeholders, refine their understanding of the problem-space, and ideate from there. Additionally, it is the practice of the team involved in the creation of this programme, that each project should conclude with an "unpack" phase—an opportunity for collective reflection on practice. We could term this "Critically Reflective Design Thinking."

Taken at the macro level, each presentation of the programme is merely another prototype tested by the incumbent cohort, tutors, and participating external partners. What emerges from these subsequent deliveries is a body of tacit knowledge and a refined programme responsive to the prevailing external conditions and contextual "curriculum" that is delivered by the partners' topical concerns.

Since its inception, there have been, including the pilot, four formal iterations of the programme. The article is presented as a chronological review of each iteration, drawing overall conclusions at the end.

Part 1: Pilot Studies

In order to gain an understanding of the appropriate pedagogic approaches and to gain insights from students, the team devised and ran a series of six-week pilot projects in collaboration with multinational partners: Lego, Hasbro, Philips, and Unilever (all leaders in their respective fields and early-adopters of multidisciplinary team-based product development). Teams of undergraduates studying industrial design, business marketing, and engineering technology worked together on client briefs under the guidance of the programme development team and were observed by an independent research assistant. The results of these projects reinforced stereotypical viewpoints about the working practices of different disciplines and the thinking styles that they adopt, as described by Roger Martin of the Rotman School of Management (Dunne and Martin 2006). These were also evident in the academic team developing the

programme. Additionally, the pilots revealed a number of key insights that allowed the team to establish three principles that needed to underpin the programme going forward:

- Create physical and psychological environments in which creativity would be nurtured; in order to express themselves and their disciplinary expertise, or to question that of their peers, participants needed a suitable "safe-environment" in which to learn.
- Develop a community of practice in which a "common language" would be learned; significant potential for misunderstanding could arise from the specificity of meaning attributed to key terminology as it relates to the different disciplines.
- Promote shared values through developing self-awareness in pursuit of cooperative learning; dealing with the inherent ambiguity of projects with a more disruptive intention can be unsettling when the scope of exploration is less clearly defined.

The design students involved in the pilots were confident dealing with the inherent ambiguity in the projects because they had experience of this from their prior studies. This, in itself, presented challenges within the groups around leadership, assumed responsibility, encouraging equal participation, and so forth. Additionally, Design-Thinking literature emphasises the importance of rapid experimentation and "failure" in pursuit of knowledge or as "learning in disguise" and, indeed, the team's own research and professional practice experience reinforced this. This too represented a challenge for the student participants who were conditioned by their prior educational experience to pursue "right first time" solutions. The programme was, therefore, built with the aim of establishing a community of practice within which understanding was nurtured and freedom to experiment, to "fail," and to create were celebrated. Pedagogically, the team determined that through committed, collaborative engagement in a creative, explorative activity, deep, cooperative learning is achieved, resulting in increased creative-confidence. Johnson and Johnson (1987) suggest five elements of cooperative learning: positive interdependence, individual accountability, face-to-face interaction, social skills, and processing. They saw these as essential for effective group learning, achievement, and higher-order social, personal, and cognitive skills (e.g., problem solving, reasoning, decision-making, planning, organizing, and reflecting). Creating a programme based around these principles was fundamental, but a radical departure from the norm and contrary to the prevailing Higher Education climate in which risk-taking, and particularly failure, were counter-intuitive when pursuing institutional requirements to achieve "good degrees" and high-grade attainment. The resultant programme was designed to provide a framework within which experimental group-based projects, connected with external partner organisations, formed the primary vehicle for learning the purpose of which was personal development rather than acquisition of specific, pre-determined knowledge or skills.

Part 2: Multidisciplinary Design Innovation 2008–2013

Context

Resulting from the pilot studies and based upon the socio-political and economic circumstances outlined in the introduction, the Master's programme was designed to be intensive, delivered on-campus over three semesters, and in close partnership with external organisations. It welcomed a multidisciplinary cohort of students responding to real-world challenges working under the guidance of a multidisciplinary team of academics. The stated intention of the programme at this time was to create graduates who:

1. Developed the personal capabilities to: a) realise valuable design-thinking processes and methodologies; b) recognise and articulate creativity through the different languages of design, business and technology in pursuit of a new

common language for collaborative practice; and c) tolerate ambiguity by framing complex problems and situations to allow innovation to occur.
2. Engaged externally, through practice to: a) promote discourse between students and external organisations and audiences in order to validate and contextualise their work; and b) communicate the value of this approach to innovation through online and physical publication and exhibition.
3. Establish a reflexive practice to: a) recognise and articulate the richness of personal motivation as a focus for lifelong learning; and b) encourage self-direction and aspirations towards social responsibility and sustainable development.

Programme Structure

Each semester comprised of a large project module, a personal development module, and contextualising modules in the complementary subjects—"Understanding the Business/Design/Technology Context" (Figure 1). The contextual modules ran through the first two semesters and were intended to enable students to make the connection between theory and practice, exposing them to the language and practices of the host discipline.

Problem-based, co-operative learning was fostered through three, semester-long modules—Familiarisation Projects, Experimentation Projects, and Integration Projects—through which students explored problem and solution spaces.

These project modules allowed students (and staff) the freedom to explore and learn collaboratively through projects with commercial, public, and third-sector organisations. In the early part of the first semester, the projects were internal, based around personal projects and theoretical models; where students were initially given a "safe environment" (Bailey and Smith 2010) in which to orientate themselves to the demands of multidisciplinary working and to develop the self-awareness necessary to separate "self" from "team." In the second, they worked with a number of external clients on short projects (two to three weeks typically) whilst in the third, separate, smaller teams had their own client project to manage themselves. Over the course of the three semesters, the role of the client in the project increased as the students became more comfortable with team-working and innovation practice approaches and were better able to concentrate on the project, the client relationship, and delivering real value in projects of genuine importance to the client. These final semester projects were twelve weeks in duration.

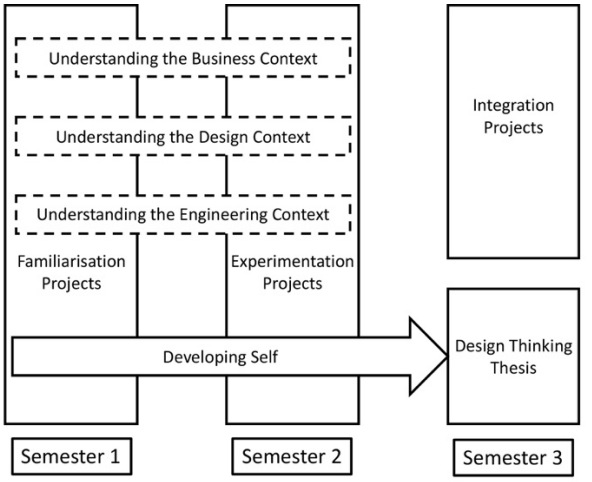

Figure 1. The 2008 Programme Structure
Source: Bailey and Spencer

From the outset, acknowledging the fact that innovation happens when individuals work at the edges of their disciplines, or where disciplines intersect (Johansson 2006), there was the expectation that students would work outside their comfort zone. To support this, the programme formalised the self-reflexive approach through the module "Understanding the Interdisciplinary Self," which allowed all students, individually, to relate their project-based experiences to theory so that they might understand how they could contribute to the multidisciplinary team whilst simultaneously recognising that their behavioural traits and those of their peers were not uncommon. This strand fed into their Design-Thinking thesis, in which students explored and defined their personal position during the final semester. Students could choose whether to pursue an MA or MSc award based upon the methodology adopted in their final semester projects.

Assessment Strategy

The programme team knew that it would be essential to encourage students to adopt an experimental approach in their studies, and this would require a shift in emphasis from the norm in design education, supporting experimentation and growth rather than simply rewarding the delivery of designed outputs. The assessment and feedback-for-learning for this new Master's programme, therefore, needed to provide a supportive structure that would encourage experimentation and reward learning "at the edges" of knowledge for all students.

In order to promote risk-taking and learning from failure, the team proposed that the programme should be assessed only as pass or fail. This proved particularly difficult to validate and eventually, in order that students could graduate with a classification, the approach was adopted only for the first two semesters, with the third graded. Inherent in this was a risk that the final semester would become "all or nothing" but in practice, the team saw that the learning culture and behaviours established in semesters one and two carried through into semester three. The self-reflexive focus engendered through the "Understanding the Interdisciplinary Self" module was critical to the success of this approach. Students were encouraged to be aware of their individual contributions, where they could afford to take risks in pursuit of the project objectives and how to take best advantage of collaboration; an approach supported by the likes of Winkel (1999) and Boud, Cohen, and Sampson (2014).

A "learning eco-structure" (Figure. 2) has been used to support students' growth beyond academic attainment. Formal assessment in semesters one and two was of the individuals' learning derived from the project activities undertaken. This was presented in a "Personal Portfolio of Practice," an account of what took place and a reflection on the consequent learning related to both theory and practice. Informally, assessment was established in the structure and culture of the community of practice and took three forms:

- Students continually assessed themselves and each other through their practice. Just as each student was a recipient of assessment and feedback, they were a giver as well, taking on the role of both co-operative-learner and tutor.
- Tutors, in supervising the projects, often took a participatory role in on-going co-creative practice activities. This established trust between the students and tutors as well as providing on-going formative feedback opportunities.
- Clients played an informal assessment role as well, providing critique and validation from a professional standpoint. Students placed particular value on this external validation and the confidence that it built.

These informal aspects of assessment established a climate within which the majority of students flourished and were driven to deliver high quality project outputs (the sort that would have received excellent grades had they been assessed against typical design education criteria) in order not to let themselves, each other, or the clients down. Whilst the subsequent iterations of

the programme saw slightly different assessed components, the assessment strategy, and principles that underpin it, has remained the same throughout.

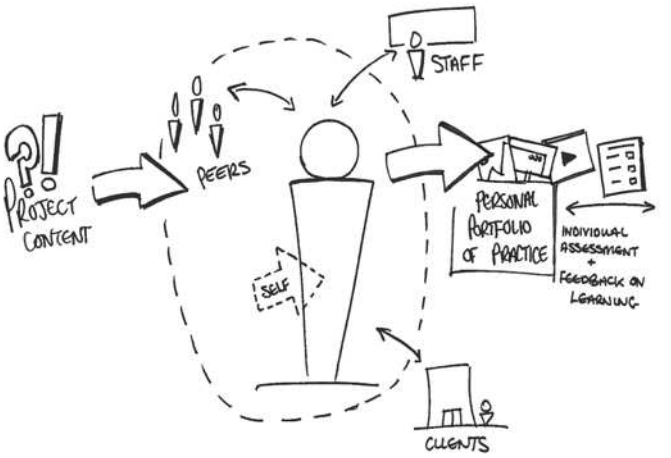

Figure 2: The Learning Eco-Structure
Source: Illustrated by Nate Sterling 2015, Based on Authors' Original

Critique

In the first iteration of the programme, ninety-seven students graduated over a five-year period, with twice as many designers in the cohort as business and technology graduates combined. Several other disciplines were also represented, with Politics, Education, Social Sciences, and Fine Art all involved.

For the first three years, European Regional Development funding was deployed to provide studentships to help students afford to study. This funding existed to promote knowledge exchange to support regional small- to medium-sized Enterprises (SMEs) in establishing an innovation culture, developing new products, and/or creating new employment. This was beneficial in enabling the programme to launch and attract early cohorts. However, the regional SME focus inhibited the team in running projects with as many large corporations as they had originally envisaged. In hindsight this has proved to be a very good thing because overall the balance of project collaborators has been fairly evenly split among regional, national, and global organisations, and across sectors. Consequently, staff and students have had opportunities to understand the relationships between global trends and local action. Indeed, surveys of alumni from this period have indicated that the projects undertaken with smaller, local organisations, and particularly social enterprises and charities, helped them understand the real value of their work and the contribution that they, as individuals, could make.

> For me I think the biggest impact on my creative confidence is that the charities and social enterprises that we worked with tend to be smaller and because of that they are able to implement the changes suggested by MDI much faster, I think being able to see your work change a client for the better can really help. You also don't have as much self-doubt when working with smaller companies. (MDI graduate surveyed in 2018)

The suite of projects undertaken under this funding provided data that enable the team to identify an eight-stage approach to design-led innovation projects undertaken with SMEs (Bailey, Smith, and Aftab 2013).

Significantly, a review of projects at this time identified that those that delivered greatest perceived value to each stakeholder were those where co-creation of a "common purpose" as part

of problem-framing was achieved, thereby giving each stakeholder a sense of ownership and responsibility for solution creation and implementation.

Values (to Student, Partner Organisation, Society, and Academia)

Contemporaneous reviews of student, partner, and colleague feedback highlighted that the programme offered different values and related differently to different stakeholders.

Table 1: MDI 2008–2013 Stakeholder Values

Stakeholder	*Value*
Students	Part-funding which helped them commit to postgraduate study that afforded the opportunity to be experimental and work directly with "industry."
	Developing a CV of innovation practice experience with client organisations comprising multiple clients, across a different sectors and business types.
	A new creative confidence and self-awareness resulting from experiential learning and extensive professional development. They had also learned how to collaborate with others or learn new skills in order to make up for any perceived deficiencies.
	Diverse graduate destinations: roles within larger organisations who were adopting Design-Thinking; SMEs in roles that took advantage of their broader perspective (often an asset in a small business where employees are required to fulfil multiple roles). Almost 10% of graduates started their own businesses and a similar number registered for PhDs.
Partner Organisation	Benefitting from access to new ways of working with multiple disciplines to define and solve complex problems.
	Networked knowledge and cross-fertilisation of process knowledge which was informal and happened as a consequence of students and academics taking tacit knowledge developed in one context and applying it in another.
	Access to new talent with the course offering a protracted selection process through which potential employers could evaluate students' employability over the duration of a project.
Society	Innovative solutions from projects responding to a social or civic concern with local government, public-sector, community groups and charities resulting in a direct and meaningful contribution to society.
	Graduates equipped as positive agents of change as a result of tackling challenges faced by organisations in the Community and Voluntary sectors.
	The Regional Development Agency studentships delivered a series of specific, measurable outputs related to business growth; e.g. 48 innovation studentships delivered, 40 SMEs supported and 7 jobs created/safeguarded.
Academia	Tacit knowledge of the programme team, developed and tested through close industry engagement ensured that the founding principles and approaches of the programme remained current and valid.
	Contemporary practice and business knowledge was brought into the programme by partnering organisations including a number of specialist innovation agencies such as Park Innovation, Matter, Plan, Impact Factory.
	Pedagogic studies were published about the design and delivery of the programme.

Source: Bailey and Spencer

Programme Deficiencies

In Design Thinking, the value to be gained from testing a prototype is only truly realised if the testing is honest and critical. In the same way that the students were encouraged to prototype their ideas, externalise them, trial and refine them, we recognised that each iteration of the programme offered an opportunity for improvement based on collective critical reflection. Over the period 2008–2013, there were aspects of the programme that did not work as well as the team had intended. These offered a platform for future development.

The programme failed to engage with technology-futures in a meaningful way. The aim had been to introduce students to newly emerging technological developments in a way that would enable them to conceptualise future solutions taking advantage of breakthrough or far-horizon technologies. This did not happen, partly because the nature of the partners' projects did not offer this scope, and partly because staffing restrictions within the Engineering Faculty limited the breadth (but not quality) of knowledge coming into the curriculum.

The Context modules were exclusive to those students who had not studied the particular subject as undergraduates. Each student took only two of the three modules, and this was unhelpful to overall cohort cohesion and proved difficult to administer when students did not see themselves as fitting neatly within any one disciplinary "box." In fact, it was counterintuitive to them when the declared purpose of the programme was to promote multidisciplinary collaborative working.

"Weaker" students tended to exploit the pass/fail assessment, and whilst there was peer assessment within the final semester assignments, this was not formalised and resulted in some students "coasting" and taking advantage of other students' efforts. It should be emphasised that this happened in very few instances but was, nonetheless, a concern.

In spite of an assessment design that was intended to promote experimentation, project outputs were not always as ambitious as we would have hoped. Whilst assessment plays one part in driving behaviour, there are multiple other factors at play: topic, client ambition, constitution of the team, etc. In contrast with the view expressed by students about the value of working with smaller organisations where their work had more potential impact, it was clear that the larger the organisation was, the greater the client ambition and the more adventurous the student response.

The need to provide a pipeline of project partners and briefs meant that projects were purely opportunistic in the way that they were framed; they were not driven by, or contributing to, any specific research agenda beyond the general pursuit of knowledge regarding the pedagogy and practices of multidisciplinary innovation.

The methodologies employed within the projects were very free-form and not often rigorously theoretically anchored: this helped projects progress swiftly and encouraged the development of exciting, sometimes unexpected, approaches. At this time, the programme team did not view the programme as a research site; they were not equipped to capture all that was going on or methodical in translating this into their own published methods. This was a missed opportunity.

Part 3: Multidisciplinary Innovation 2013–2017

A Changing Context

Additional to the values and deficiencies previously reported, in December 2011 two reports outlined the UK government's design priorities, initiatives, and the actions considered necessary to support research and innovation for economic growth (Design Council, 2011; UK Government, 2011). Taken together, they revealed three trends significant to the role and value of design in multidisciplinary innovation: 1, Design supports economic growth and social improvement through two distinct and discrete roles - a facilitatory leadership role of adopting designerly attitudes and approaches and the executional role of designers designing; 2, There is a

need for greater understanding about, and utilisation of, design-led approaches to support economic growth and social transformation; 3, There is a lack of knowledge and practice understanding about how to utilise diverse networks to leverage distributed creativity and intelligence.

In response to these trends and our critique of the programme, a second iteration of MDI was developed and validated. This version was based on the standpoint that multidisciplinary design-led approaches can lead a multi-stakeholder network to develop a common purpose and collective vision through the exploration of project challenges and that this will lead to greater potential for positive change by design.

The Programme Redesigned

Three significant changes distinguished the redesigned programme: (1) a move from 'Design (discipline) led' to 'design-led' (as a set of values, behaviours, activities and resources) multidisciplinary innovation; (2) a more mature relationship with external collaborators, which moved the approach to projects from consultative to co-creative (Bailey, Aftab and Smith 2015); and (3) a recognition of the value of the programme as a research site through which the team could investigate both pedagogic and practice issues. The aim of the programme remained the same, as did established elements of environment and practice.

In response to the changing contextual factors and the critique presented in Part 2, the programme structure, content and assessment strategy were all modified. The programme name was changed; market research indicated that business graduates were put off by the word 'design' in the title. This, together with the move away from 'Design (discipline) -led' encouraged the team to rename the programme MA/MSc Multidisciplinary Innovation (the MDI acronym and brand still just about worked). The purpose and ethos of the programme remained the same.

Programme Structure

The new structure (Figure 3) was created to deliver an enhanced curriculum through four knowledge strands: Planning and Professionalism (core business knowledge), Self and Community (reflective practice and team dynamics), Science and Technology Futures (emerging science and technology), Methods and Communications (designerly approaches to research and facilitating innovation). These strands effectively replaced the 'context modules' but were core to all students and ran through project modules providing an integrated learning experience, with projects the 'laboratory' within which theory was put to the test. Whilst each project remained un-graded, the Portfolio of Practice assignment for each module was now graded. Again, the focus of the Portfolios of Practice was very much on establishing reflexivity but with greater emphasis being placed on students' abilities to tie their own and their teams' practice back to the underpinning theory.

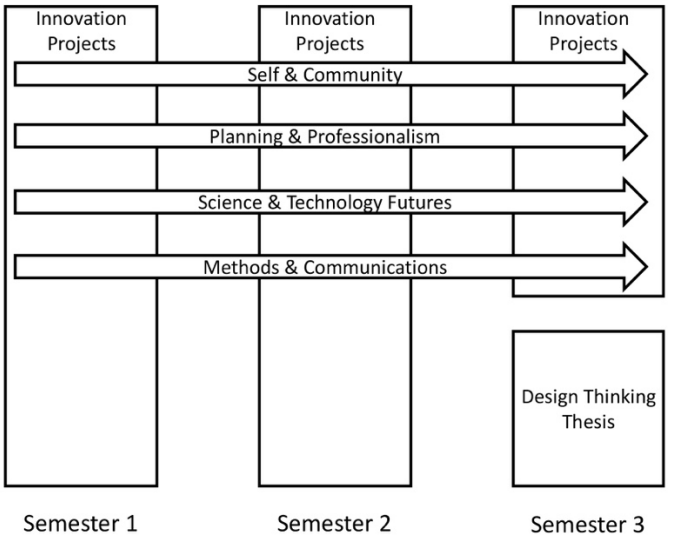

Figure 3: The 2013 Programme Structure
Source: Bailey and Spencer

The Emergence of Integrated Academic Practice:

Through this structure, a model of Integrated Academic Practice (IAP) emerged and was refined (Bailey and Smith, 2016). It suggests that project-based activity with external partners can offer a situation that promotes high-quality, pedagogically sound, 'authentic' learning, whilst offering a research site from which to gather data and validate new knowledge (Figure 4). In order to take full advantage of IAP, projects need to be established with clear scope that acknowledges the importance of research as well as the desired innovation outcomes and associated learning. Furthermore, a number of resources and conditions need to be in place to take advantage of the opportunities presented by IAP.

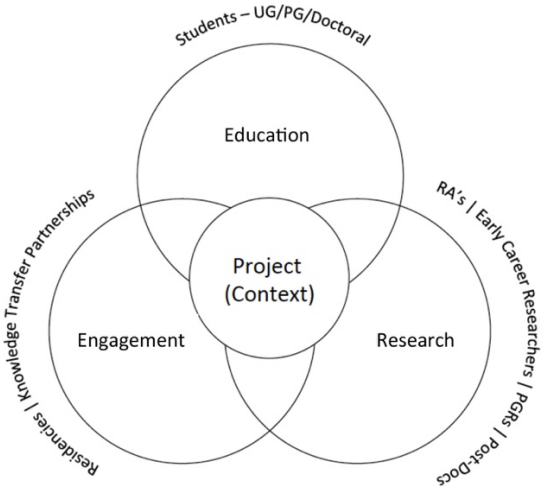

Figure 4: A Model of Integrated Academic Practice
Source: Bailey and Smith 2016

One such resource is the Innovator in Residence (IiR). The team saw that a number of student projects fell short of delivering their true potential to partner organisations due to a lack of available, appropriate university or partner resource. As the students moved on to their next project, partners were left with a glimpse of a better future, but no resource with which to help them achieve it. The role of IiR was conceived to provide this capacity and a practice-based resource that would give both the project implementation and the research potential greater reach. The IiR role provides an opportunity for MDI graduates to remain with the programme team, supporting projects whilst establishing their own professional practice and receiving mentorship from the academics. In turn, the IiRs help mentor the incumbent MDI students. In this way, the IiRs have become an invaluable connecting-tissue in the community of practice that the programme has sought to cultivate. A significant beneficial outcome of engaging IiRs is that the incumbent students can see the fruits of their work starting to manifest in implemented strategy and delivering meaningful change within organisations. When surveyed, graduates suggested "[They] showed me how valuable my work in the team was, no matter what my grades were. I think they really helped me to see MDI as a job, and not as a course, and to an extent, to value my projects output and outcomes, instead of my grades, which I believe helped me to grow and become a professional instead of being just a student. I felt purposeful and useful." And "[It created a] sense of pride when they would come ask us for stuff around our projects that they were now working on, I think having a staff-member ask your opinion and knowing it's having an input on what they're doing boosts your confidence".

Critique

This iteration saw a further sixty-seven students engage with over fifty different organisations, from the smallest local charities to global Fortune 500 corporations.

Values (to Student, Partner Organisation, Society, and Academia)

Again, a review of contemporaneous student, partner and colleague feedback and mandatory institutional programme monitoring documentation identified that similar benefits carried forward from the first iteration of MDI, but highlighted additional values to the different stakeholders (Table 2).

Table 2: MDI 2013 – 2017 Stakeholder Values

Stakeholder	*Value*
Students	Diverse projects allowing appreciation of underpinning theories and core values of what they were learning, independent of context and application.
	Making a difference with smaller not-for-profit organisations. Students felt that they were helping real people through real projects thereby developing their "Designerly Purpose" (Bailey, Aftab, and Duncan 2014).
	Global perspective gained by projects with multinationals, which helped them see their potential within the context of a world-stage.
	IiRs as "staff who valued our opinions and ideas."
Partner Organisation	Partnerships built over time allowing longitudinal suites of projects developing knowledge-creation and staff-development (through engaging with design-led practice). This afforded the programme team to be proactive in sharing emerging knowledge (Bailey, Aftab, and Smith 2015).
	Innovators in Residence who provided opportunities to develop and execute projects and embed design-led practices in organisations.
Society	Social innovations delivered through responsible innovation projects with charities, not-for-profits and larger, commercial, organisations.
	A Responsible Innovation position as a set of guiding principles in all projects ensuring that the purpose of innovation, whatever the context, should be about delivering positive societal change (Bailey, Spencer, and Sams 2016).
Academia	The collective research thrust of the programme team was brought together to form a Design-led Responsible Innovation Practice Research group, addressing the questions: How can we promote design-led responsible innovation within organisations as a driver of positive change? What knowledge, methods, tools, attitudes, behaviours, structures, education are required?
	The research capacity of the group grew, initiating 7 PhD studies, engaging a number of Research Associates through specific funded projects.
	A research partnership between the Business and Design Schools emerged, recognising a convergence in interest surrounding the relationship between design-led approaches and entrepreneurial leadership.
	Partners have shared contemporary practice, knowledge and know-how as well as contextual market knowledge thereby helping maintain currency of programme knowledge and formation of the Responsible Innovation position.
	Collectively, between 2013 and 2017, the team published 21 papers and articles relating to both disciplinary (or multidisciplinary) practice knowledge and pedagogy.
	The team's design-led multidisciplinary practice and IAP approaches were adopted as central methodologies in three collaborative research programmes: AHRC Creative FUSE NorthEast and ERDF Creativity Works (total combined value c£4m) and ESIF Horizon 2020 International GETM3 programme (c €1m).

Source: Bailey and Spencer

Programme Deficiencies

An honest critique of MDI 2013–17 revealed certain deficiencies from which, again, to develop the programme further.

"Technology Futures" remained a difficult area. The team concluded that the scope of technological advances is so diverse that it is not possible to deliver a coherent and timely curriculum that has relevance to the ongoing projects. It is most beneficial to bring in expertise on a project-by-project basis.

Projects occasionally became process-driven and lacked spontaneity and drive leading to some 'safe' solutions where students took comfort in the activity of pre-prescribed methods, planning and team organisation than confront the ambiguity and uncertainty presented by the subject of the project. This led to wasted time and 'safe solutionism' when the project deadline loomed. This could be attributed to a greater emphasis on, and availability of, contemporary theory as more literature was published in this space and general awareness of Design Thinking in business, and on-line tools to support it, emerged. The academic attainment of students joining the programme during this period was also higher, and a more theoretically grounded curriculum was delivered resulting in students taking a more academic approach in some projects. This was simultaneously beneficial and disadvantageous because it is important to maintain a balance between desk-based research and the sort of generative, practice-based activity that encourages learning through failure and stimulates genuine breakthrough innovation – this was seen to be missing is some projects.

In contrast with this concern, external stakeholders and partners were very enthusiastic in their praise of the students and their work: they appreciated the depth and variety of thinking. The programme has failed to communicate the many great stories emerging from this work.

Tim Brown, suggested that T-shaped individuals were not "jacks of all trades" and yet the MDI programme in this period became, in some respects, all things to all people. Whilst this could be an asset, it affected the clarity of message that the programme was able to project and therefore the students and businesses it was able to attract.

Part 4: Multidisciplinary Innovation 2017 Forwards

A New Context

In response to emerging trends and our critique of Multidisciplinary Innovation practice and education, a third version of the programme was developed based upon the premise and promise of design-led multi-disciplinary *responsible* innovation practice.

The Design Council's response to the UK government's Industrial Strategy Green Paper, "Design: Delivering a new approach to growth," was influential. This presented a Growth Blueprint that aimed to deliver resilient, inclusive and sustainable growth by providing a design-led bridge between initial ideas and innovation (Design Council 2017; UK Government 2017). Simultaneously, Innovate UK, the UK government's innovation agency, started funding early-stage design interventions through "strategic design" as a means to guiding the innovation journey. Both reinforced MDI's next iteration.

The emergence of "responsible innovation" (RI) as a fundamental principle of MDI and the programme's research into what it is (Bailey, Spencer, and Sams 2016) and how to teach it (Spencer et al., 2017) introduced a new set of contextual considerations. Taking a responsible innovation perspective does not have to be at odds with design-led agency for economic growth or those enabling societal transformation and citizen empowerment. Owen, Bessant, and Heintz (2013, 27) set the context for RI: "innovation has not only produced understanding, knowledge, and value (economic, social, or otherwise), but also questions, dilemmas, and unintended (and sometimes undesirable) impacts."

Collectively, these drivers reveal a number of trends significant for the role and value of design-led multidisciplinary innovation: 1) an inclusive early-stage design-led approach can help define appropriate targets of responsible innovation and explore the rights and roles of the public within them; 2) inclusive early-stage design-led approaches can also inform strategic decision making by developing, with a multi-stakeholder-network, an understanding of innovation impacts and potential consequences; and 3) the facilitatory role of design can be usefully deployed to provide a bridge between early ideas, stakeholders and different, potentially competing, agencies.

The Programme Redesigned

The IAP model allows the programme to be more explicit about the research that is conducted through the students' participation in challenge-focused, innovation-seeking projects, intelligently situating academic expertise, funded research engagement, and active student learning with the priorities of external businesses and communities as the basis for research that explores approaches to inclusive front-end innovation. It highlights the reciprocal values that benefit students, partners, society, and academia in project-based knowledge co-creation and sharing. Focussing on RI has not limited the scope of project partners or project topics but, rather, added a particular lens through which the programme can seek to support organisations and communities to develop resilience through establishing the capabilities to respond to challenging situations by scoping and defining new growth opportunities using design-led practices.

Structure

This latest iteration of the programme is a collaboration between Northumbria University's Schools of Design and Business and is located in an off-campus design business centre. Students enrol from any disciplinary or professional background to work in a research and innovation consultancy-style learning environment. RI capabilities are developed through a number of core programme principles that capitalise on: connected strategic projects with partner organisations, communities and networks; a community of practice with purpose under the guise of the design-led RI practice research group, which provides a safe environment and common-language for practitioners and researchers; the creativity of a connected and networked core multidisciplinary team; utilisation of compelling practice outputs to drive ambition and foster co-creation amongst diverse groups; valuing project outputs as data in order to develop strategy to support social and organisational transformation (Spencer et al. 2017).

The new programme structure is directly derived from the IAP model, using three integrated modules, each of which hosts a specific macro research question whilst simultaneously providing a framework within which co-creative, externally connected projects are undertaken. These projects, undertaken in teams, are conducted alongside academics, IiRs and researchers; generate knowledge about the project stakeholders' immediate and future challenges; and produce strategic insights and assets (designs for products, systems, services, strategic plans, etc.) (Figure 5).

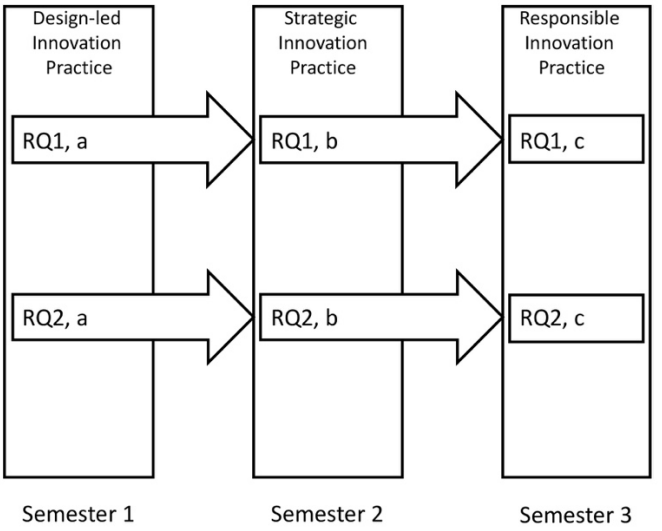

Figure 5. The 2017 Programme Structure
Source: Bailey and Spencer

Module One, "Design-led Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional develop?" and "What approaches, methods, and tools enable effective networked responsible innovation practice?"

Module Two, "Strategic Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional lead within organisations and communities?" and "What knowledge and advanced approaches support networked responsible innovation practice to deliver strategic value?"

Module Three, "Responsible Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional position them self reflexively within a global perspective?" and "Does networked responsible innovation practice enhance resilience by leading strategic organisational transformation and is this an effective and democratic methodology for producing an understanding about how to address global challenges?"

The new programme is designed to develop specific innovation practice capabilities, generate the creative confidence to design and facilitate co-creation, and enhance the employability of graduates.

Critique

The latest iteration of the programme has only been delivered for one cycle and a thorough critique at this stage would not be possible. In addition, a major research programme, Creative Fuse North East (CFNE), played a significant part in the students', and academics', practice through this presentation (Creative Fuse North East 2017). This allowed the students to engage very closely with micro-SMEs and independent professionals, allowing their work to deliver significant impact for the beneficiaries.

Values (to Student, Partner Organisation, Society, and Academia)

Table 3 presents early indications of value for the stakeholders derived from this latest iteration of the programme.

Table 3: MDI 2017 Stakeholder Values

Stakeholder	*Value*
Students	Direct impact on small enterprises that they supported and feeling simultaneously trusted and valued to advise, but equally supported by academics and, especially, Innovators in Residence.
	Some, very high achieving, students also felt a clear sense of being a valued member of a research community.
Partner Organisation	Co-creation and strategic nature of engagement, together with time to focus on their future situation rather than the immediate present needs (this observation relates to the CFNE beneficiaries)
	Networked knowledge and expertise provided by engagement with the MDI community of practice.
Society	Whilst it is too early to draw any direct conclusions in this regard, the purpose of the CFNE programme was to drive economic growth in the region through developing and deploying innovation capability and capacity enhancing interventions MDI students, academics, researchers and IiR were involved in delivering support to 21 different enterprises through this programme. Initial independent evaluation of the results is favourable.
Academia	As a direct result of the work conducted through the CFNE programme the team's practice and research has been focussed on developing rapid responsible innovation readiness and support activities. This has laid foundations for further publication and bidding activity which will see an adaptation of the approaches developed through CFNE being deployed by the team with enterprises in Armenia.
	During this period, a further dimension of the team's practice matured and was published. This identified certain value-frames within which engagement with design-led responsible innovation practice delivered through IAP present value to partnering organisations.

Source: Bailey and Spencer

Programme Deficiencies

Again, with only one cohort through the new programme, it is unwise to draw many conclusions. One observation that will guide the team as the programme matures is that, whilst academic attainment remains very high, the nature of the final semester assessment may be too complex and requires some revision. The team will continue, as they have through the life of the programme, to view each presentation of the programme as an iteration to be treated as a prototype in testing, to critically reflect upon its delivery and dynamically adapt it to address emerging situations and opportunities.

Conclusion

This article presents and reviews the development of a single postgraduate programme to consider the critical elements required to deliver Design Thinking education. From inception, the programme was concerned with developing graduates who could drive innovation by delivering creativity in business through multidisciplinary projects. To fulfil this ambition, the academic team, rather than teaching about Design Thinking, sought to establish the environment, curriculum, theoretical scaffolding, pedagogic devices, and project collaborations that

encouraged Design Thinking practices and behaviours. In this regard, the programme aligns to Kimbell's (2011) definition as it establishes Design Thinking as a cognitive style and as an organisational resource to its project collaborators.

This review has shown that, by delivering an offer that is different and distinctive from other commercial and support services, education can simultaneously establish the capabilities in its students that support Design Thinking practices and behaviours and act as a project partner to a variety of external organisations. There are three components that appear to have been important in this regard: 1) resource (academics, Innovators in Residence, researchers, and students) and management of that resource to coordinate with external stakeholders in order to engage with, and attempt to better appreciate, complex situations; 2) the agenda to develop knowledge about design-led approaches to responsible innovation through practice-based generative research, supported by an independence from client objectives and deliverables; and 3) remaining adaptive to political, socio-cultural, and economic factors in order to frame the dynamics of complex situations, thereby grasping the difficulties, conflicts, and opportunities experienced by all stakeholders.

The critical review presented in this article highlights some of the challenges of establishing Design Thinking practices and behaviours amongst a cohort made from multiple disciplines, where individuals have diverse prior learning experiences and expectations. One such challenge relates to recognising when individuals, groups, or the entire cohort begin conceptualising Design Thinking as a procedural, step-by-step approach to solving any problem. In-project coaching and formalised review sessions are mechanisms that develop reflexivity and encourage practitioners to continually question what they are doing and why they are doing it. Attempting to avoid a codified facsimile of a design process, the programme seeks to nurture creative confidence. Whilst addressing a given project situation, this relies on creating an environment that encourages exposure to, and experimentation with, multiple approaches and a fluidity of accessing, adopting, and adapting design method resources.

Further research to understand if the institutional, regional, and national factors that have helped shape this progamme are evident in other programmes that seek to teach Design Thinking is required. However, what this study has shown is that paying close attention to the relevance of an educational programme to its various stakeholders and understanding the policies and trends that influence those stakeholders can enable a heightened understanding of the context within which the programme must operate. Viewing the creation and presentation of the programme as an exercise in "Critically Reflective Design Thinking" creates a mind-set that ensures that the programme team are continually mindful of the changing context, and coupled with close external partnerships, this ensures relevance and currency of the curriculum to its context. In each manifestation of the programme, the team has tried to bring forward the most effective aspects of the previous one and use these as a platform for iterative development responsive to changing contextual factors. As such, the programme is never fixed and will continue to adapt and grow.

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